Assessing & Managing Branch Junctions in Trees

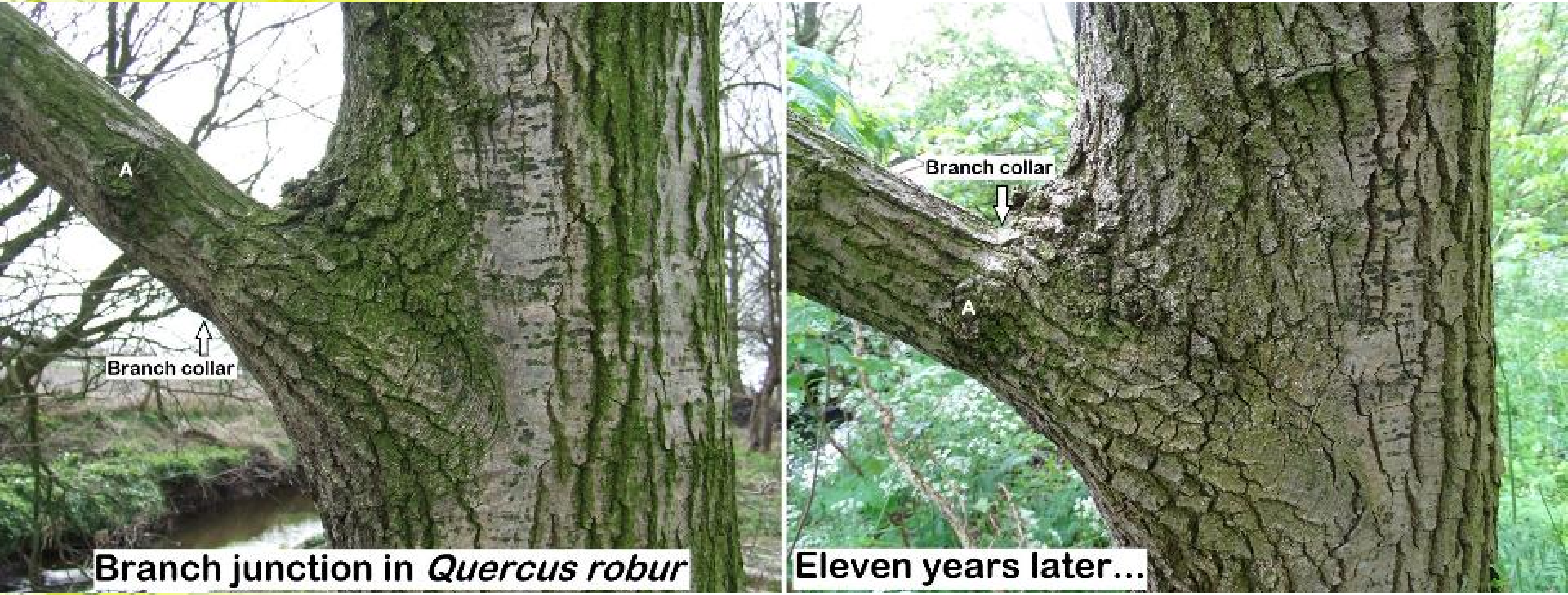
Hong Kong 2020

International Urban Forestry Conference

Duncan Slater BSc BA Med MSc PhD MArborA MICFor

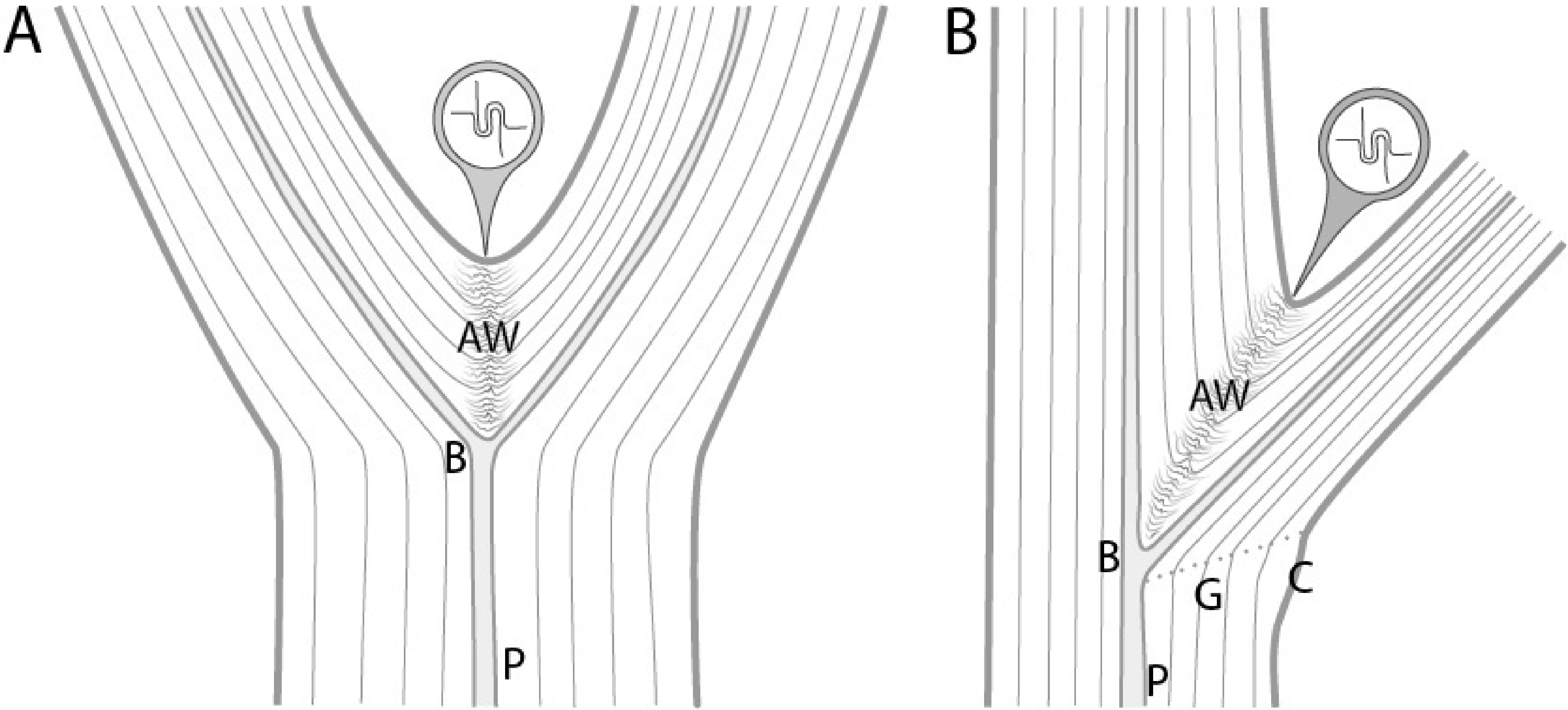
Talk Summary

- Modelling branch junctions
- Axillary wood – a new reaction wood
- The effects of natural bracing
- Is a big bulge better?
- Is a fork in a tree a defect?
- Conclusions



Modeling Branch Attachment

Branch attachment model



AW = Axillary wood
P = Pith
B = Bifurcation of the pith

C = Branch collar
G = Grain capture zone

Axillary Wood

A New Reaction Wood

Currently recognised reaction woods:

- Compression wood
- Tension wood
- Flexure wood

- Axillary wood develops in the axil of branch junctions and also has a unique anatomy and purpose

Characteristics of reaction woods:

Axillary Wood

- ✓ Formed due to specific strain scenarios acting on the tree
- ✓ Specialised anatomical changes
- ✓ Unstable when dried out quickly
- ✓ Part of the “posture-control system” of trees

Responding to Strain

Specialised Anatomy

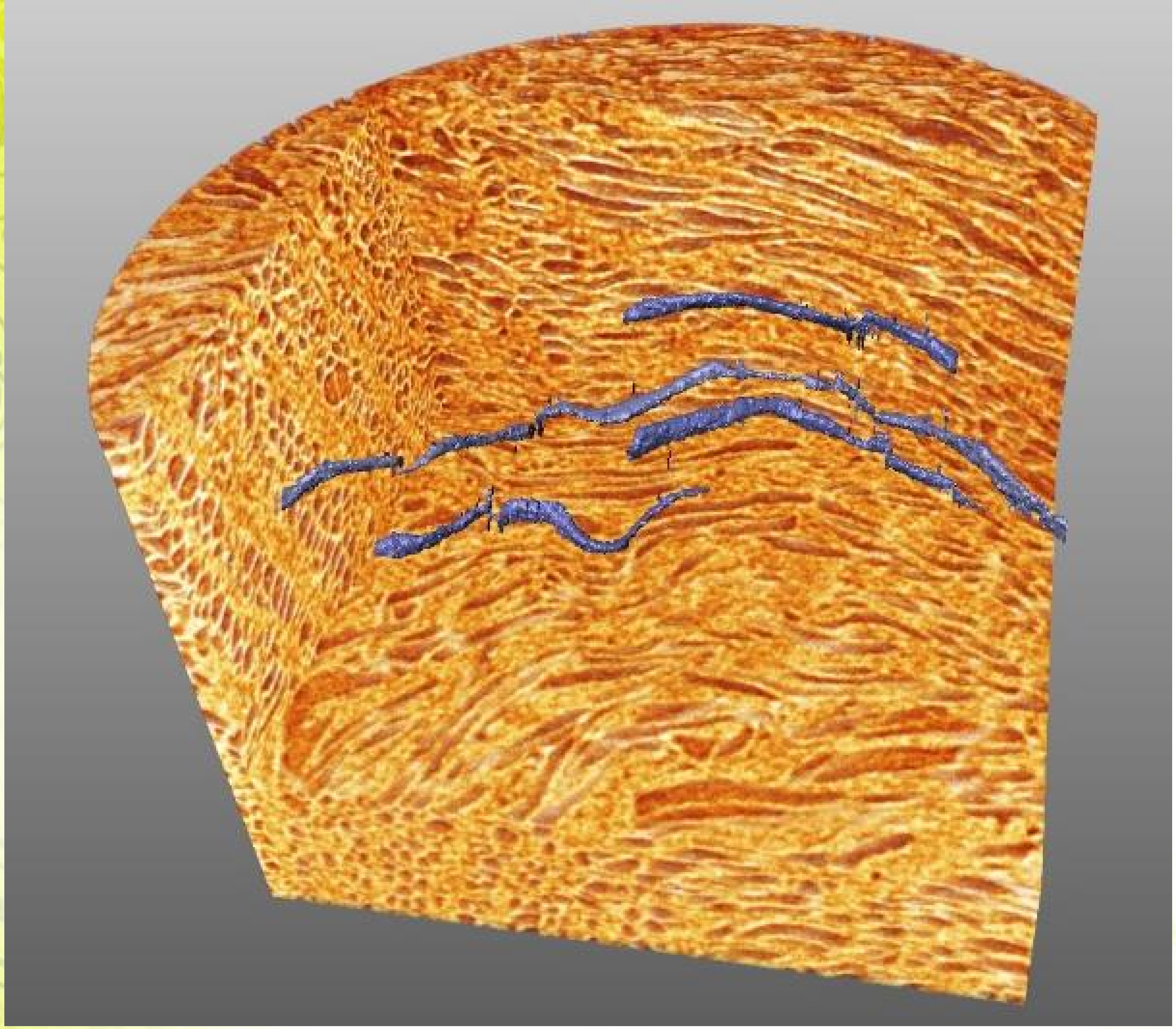
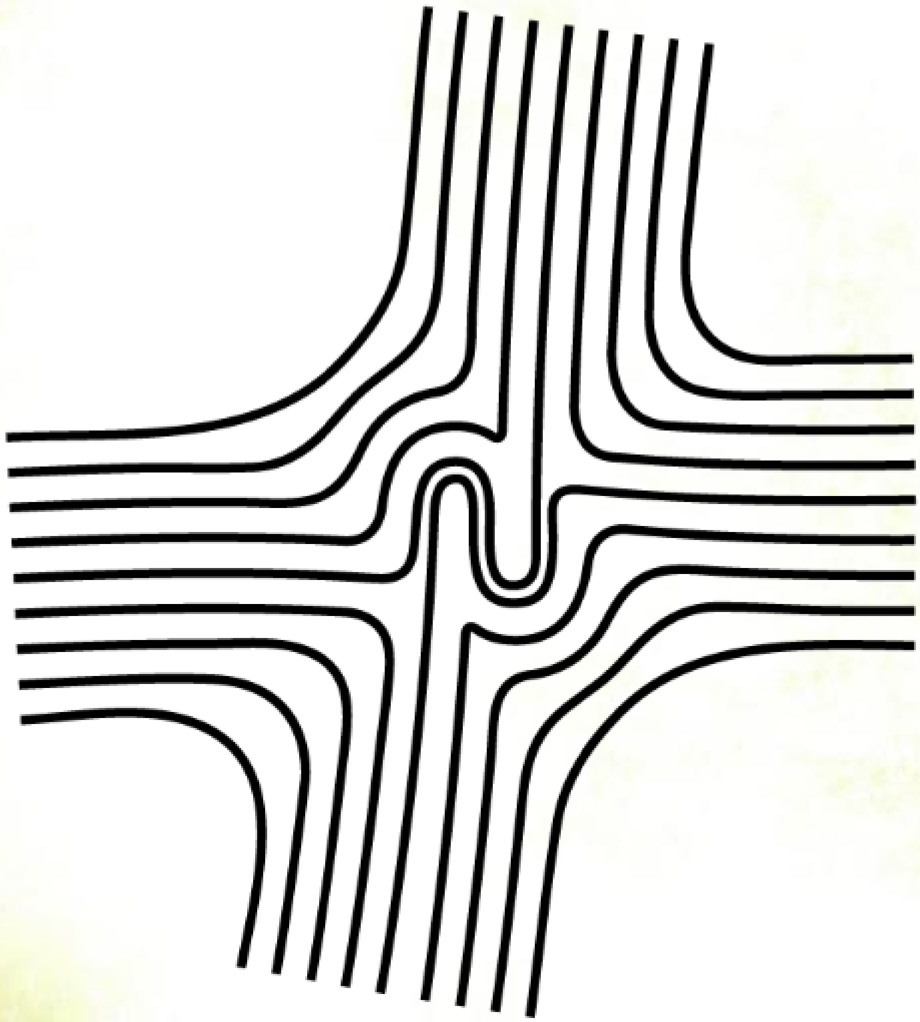


Image courtesy of the Manchester X-Ray Imaging Facility

Specialised Anatomy



Specialised Anatomy

Unstable when dried out quickly

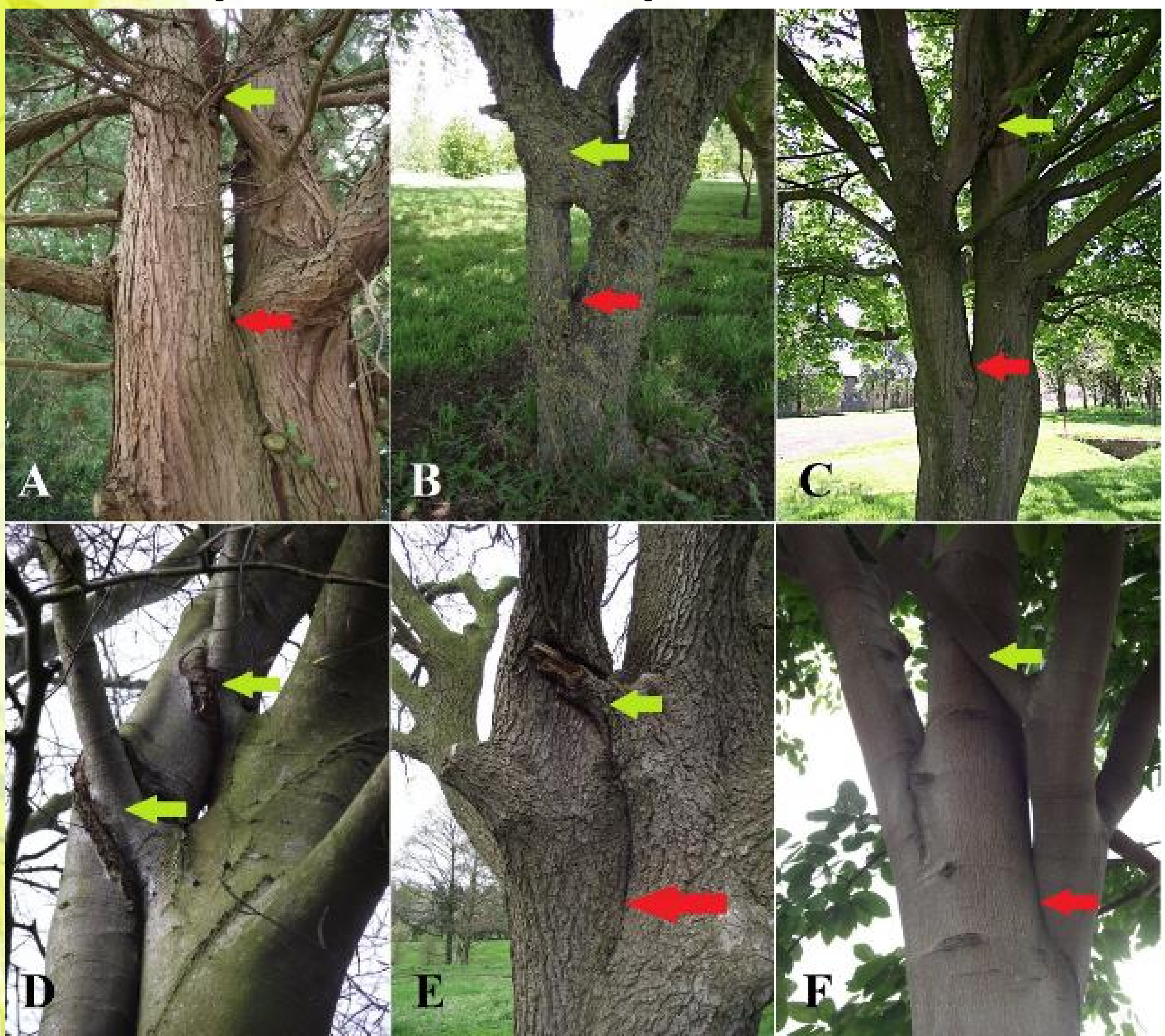
Part of the tree’s posture control

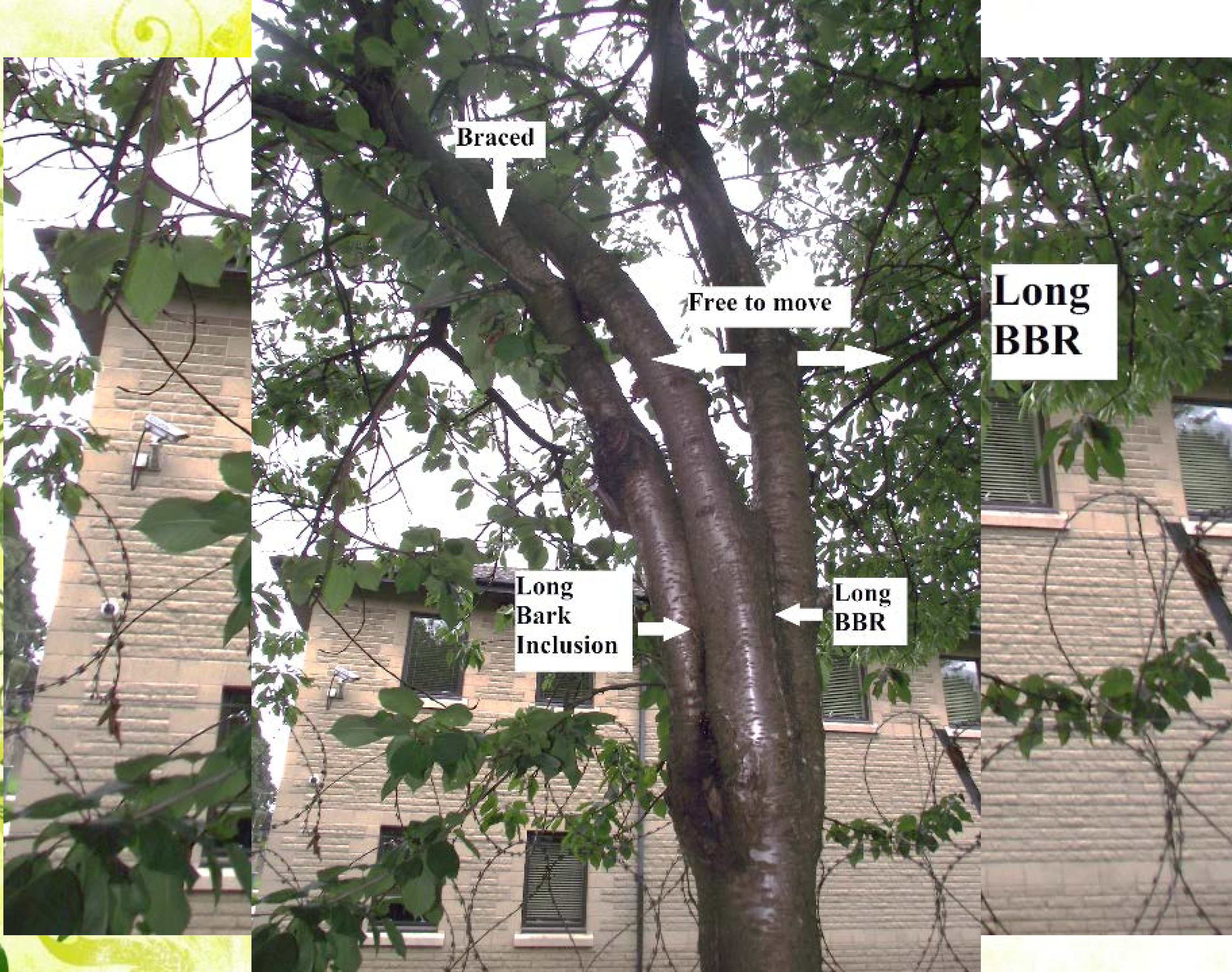
Heading cut on young variegated sycamore

Ten years later...

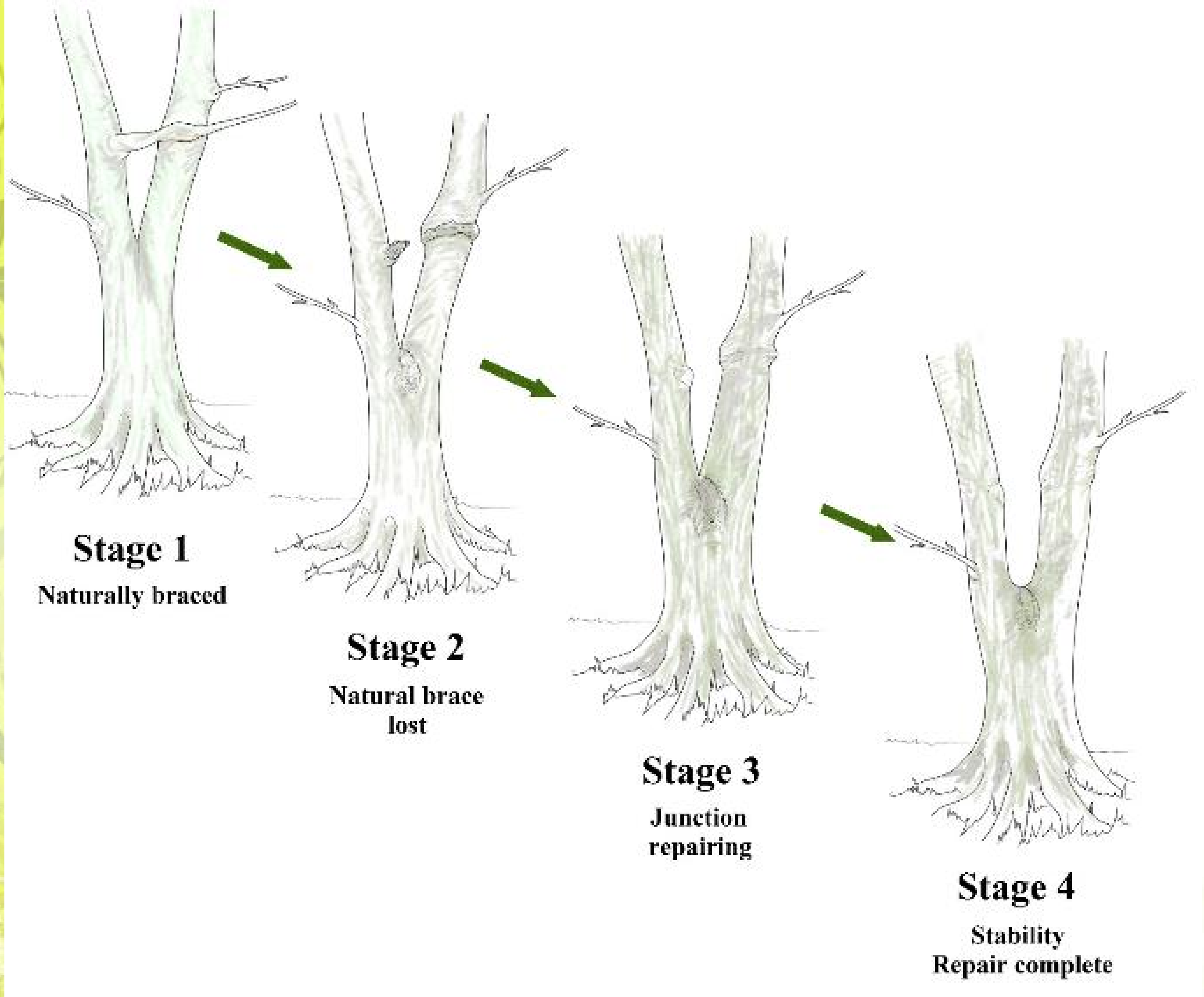
The Effects of Natural Bracing

Natural bracing:
A very common phenomenon

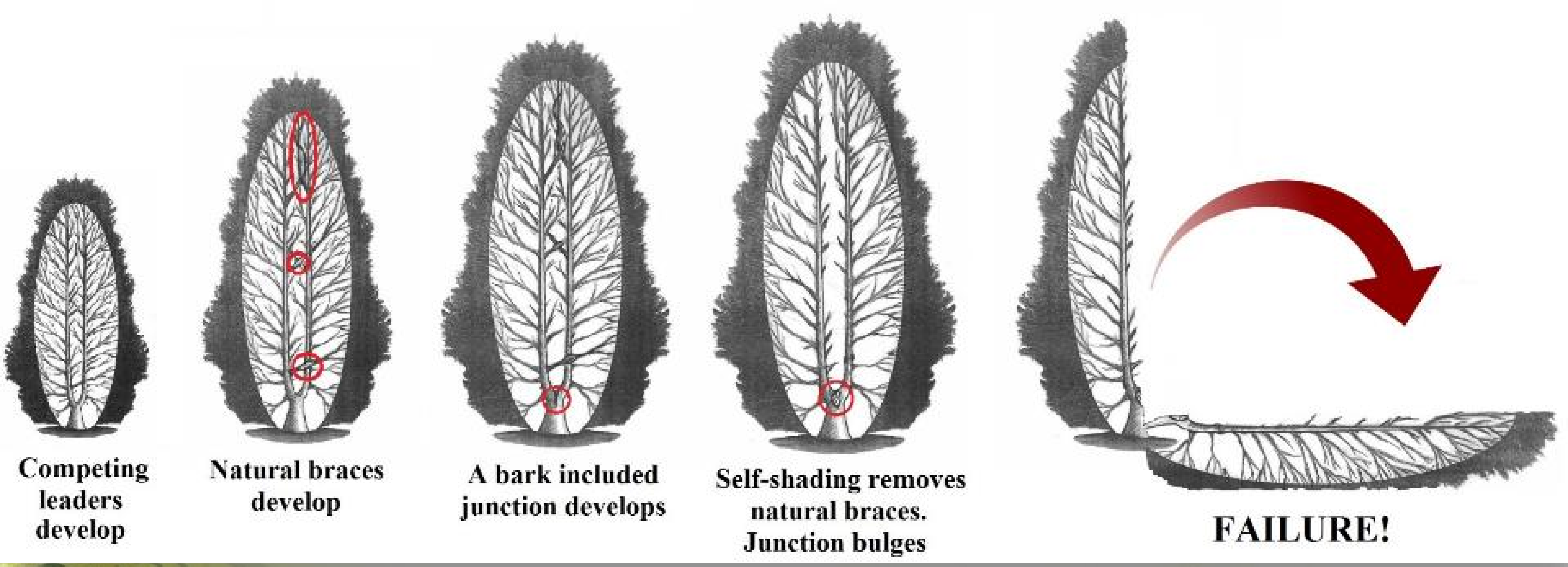



Braced
Free to move
Long
Bark
Inclusion
Long
BBR
Long
BBR

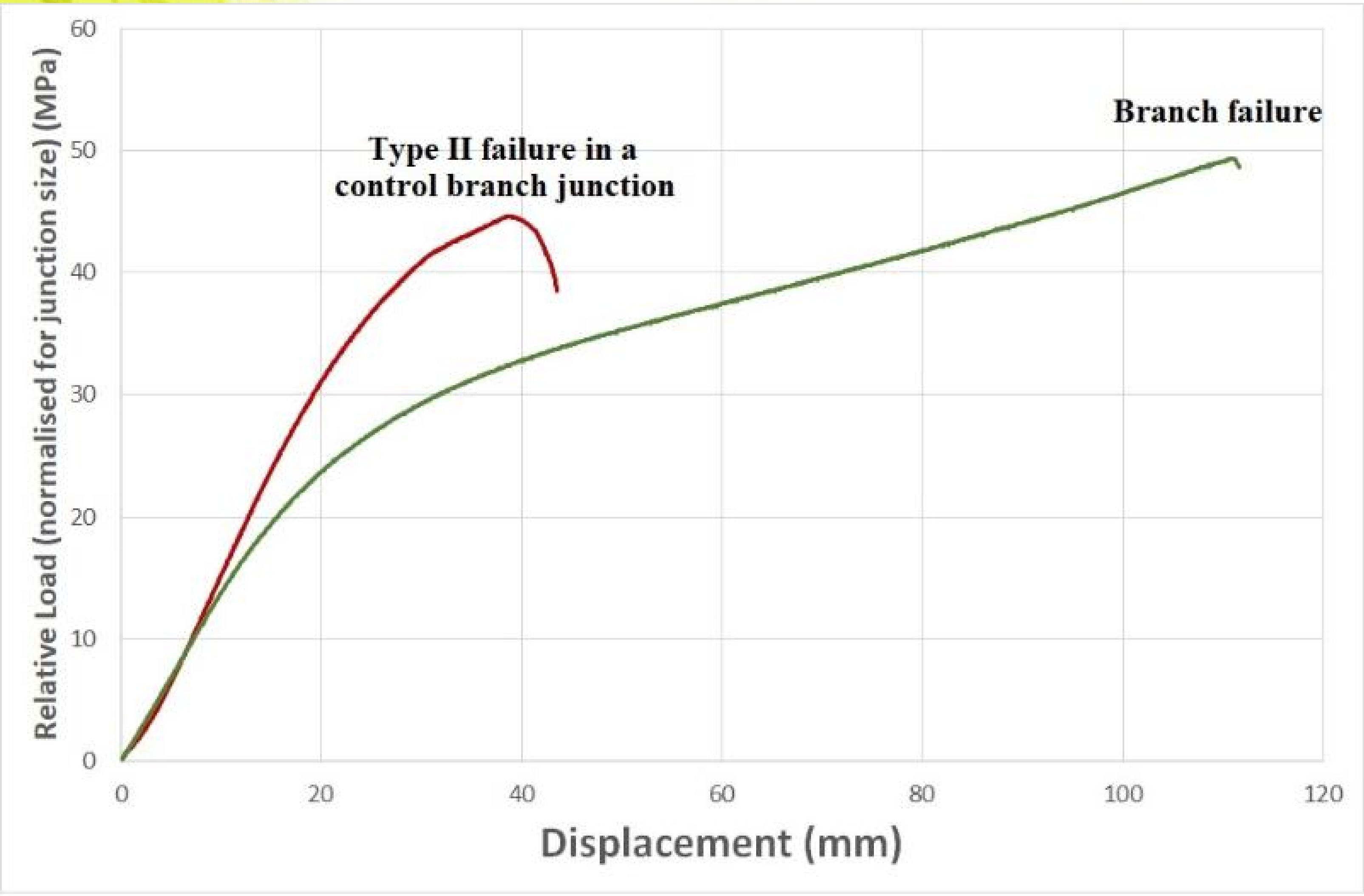
Stages of natural bracing…



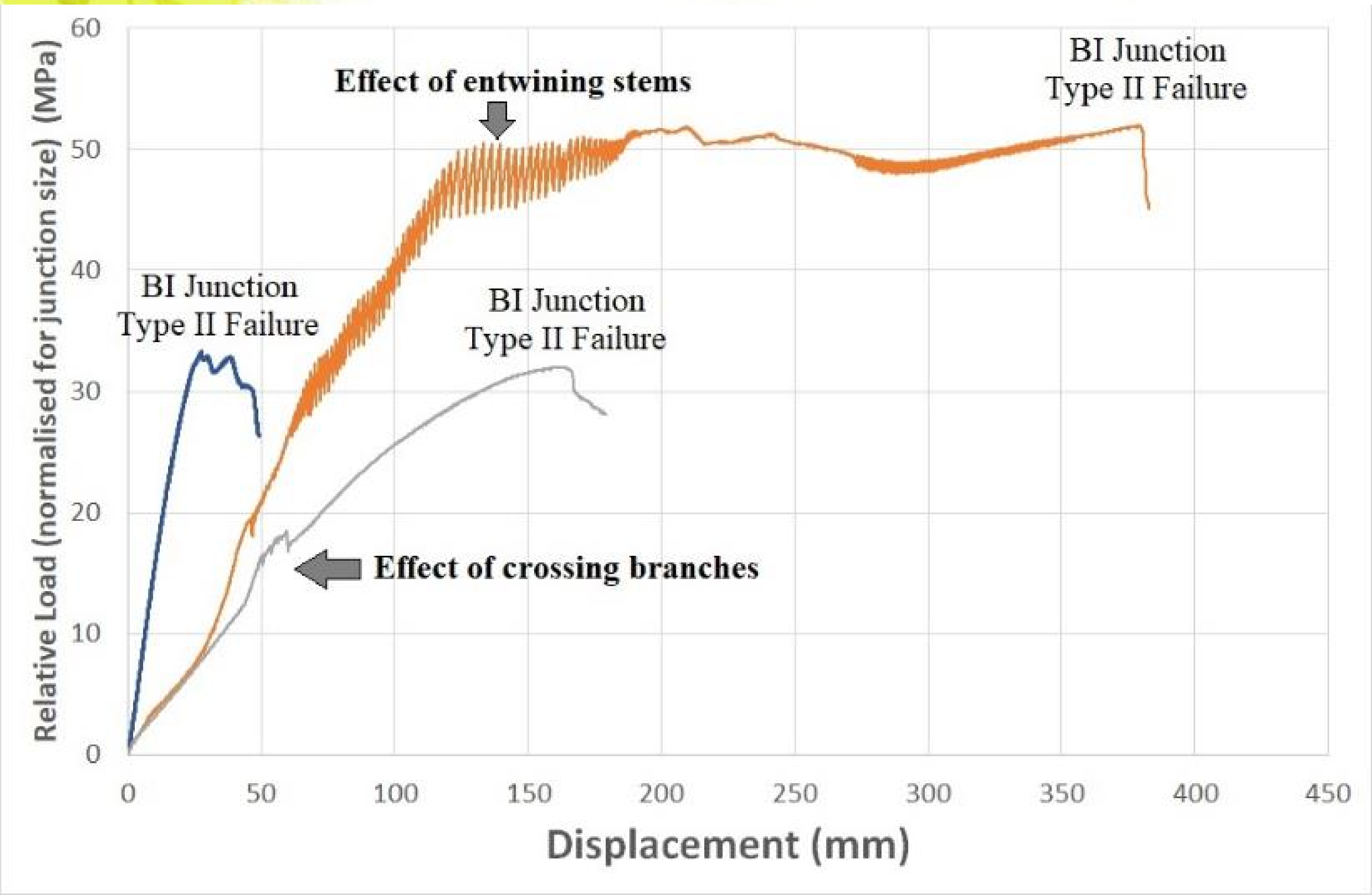
Natural bracing can explain a lot of tree morphology and failures



Meadows & Slater 2020



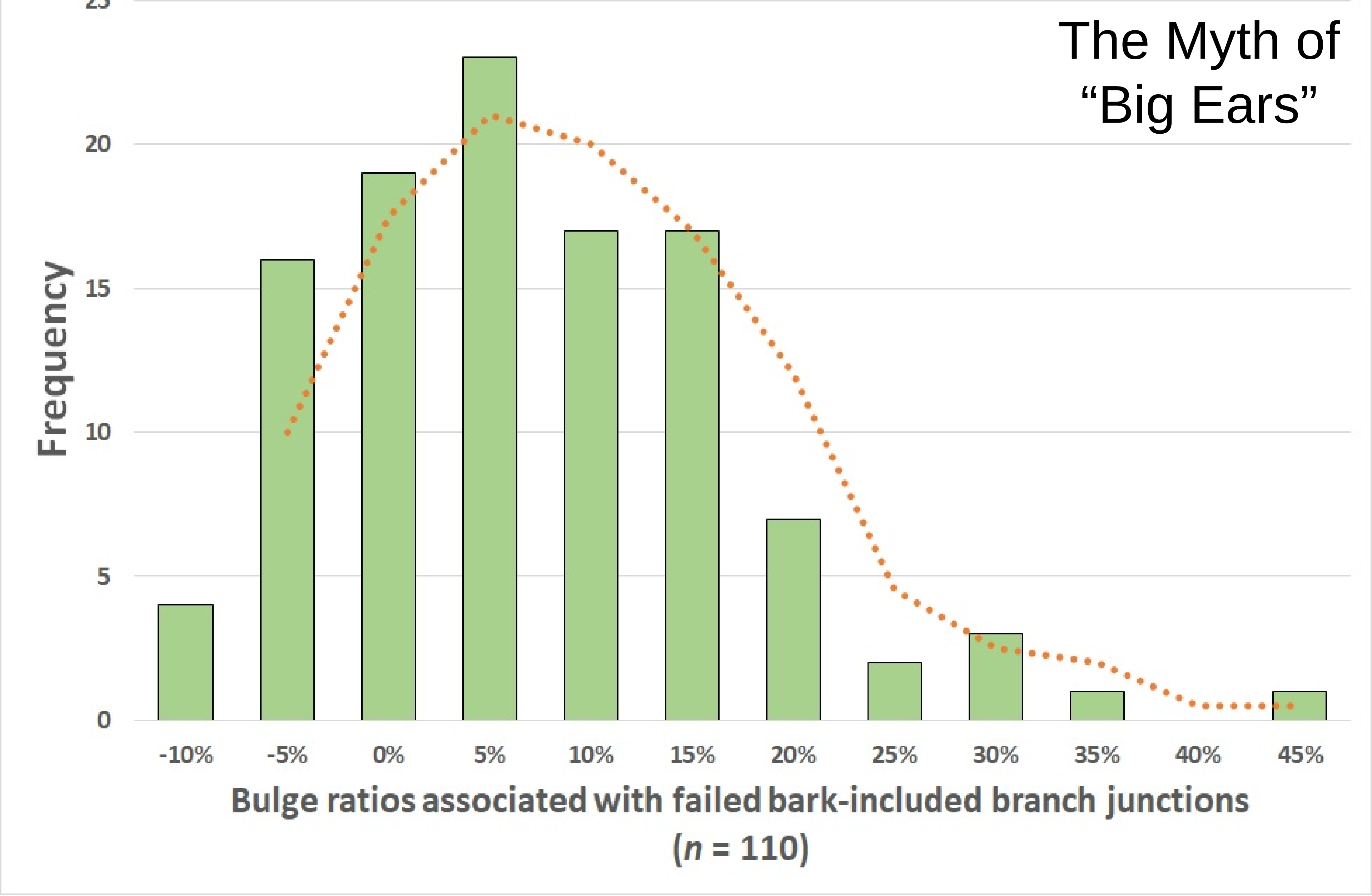
Meadows & Slater 2020



A need for education…

Is a big bulge better?

Big Ears?



Frequency of BI failures against different extents of bulging

Modelling in hazel junctions

Branch Junction Type	Mean bulge ratio ± SE	Correlation between bulging ratio and peak bending stress
Control	10.63% ± 1.25% SE [a]	R^2 = 0.15%; p = 0.862
Embedded bark	17.84% ± 2.7% SE [ab]	R^2 = 9.54%; p = 0.283
Cup union	25.4% ± 1.78% SE [bc]	R^2 = 3.66%; p = 0.188
Wide bark inclusion	32.43% ± 2.68% SE [c]	R^2 = 1.18%; p = 0.568

The extent of the bulging was not a significant indicator of the bending strength of the branch junctions tested

BULGING = NOT SIGNIFICANT

Bulging around cracks or bark?

Is a fork a defect?

Are normal branch junctions a big problem in trees?

Branches	Bases	BI junctions	Root plates	Stems	Normal junctions	Elongated Branches
3.3	2.3	2.8	2.0	1.6	1.0	1.9
Frequent	Occasional	Frequent	Occasional	Occasional	Rare	Occasional

n = 348 delegates

Data from a Super Typhoon

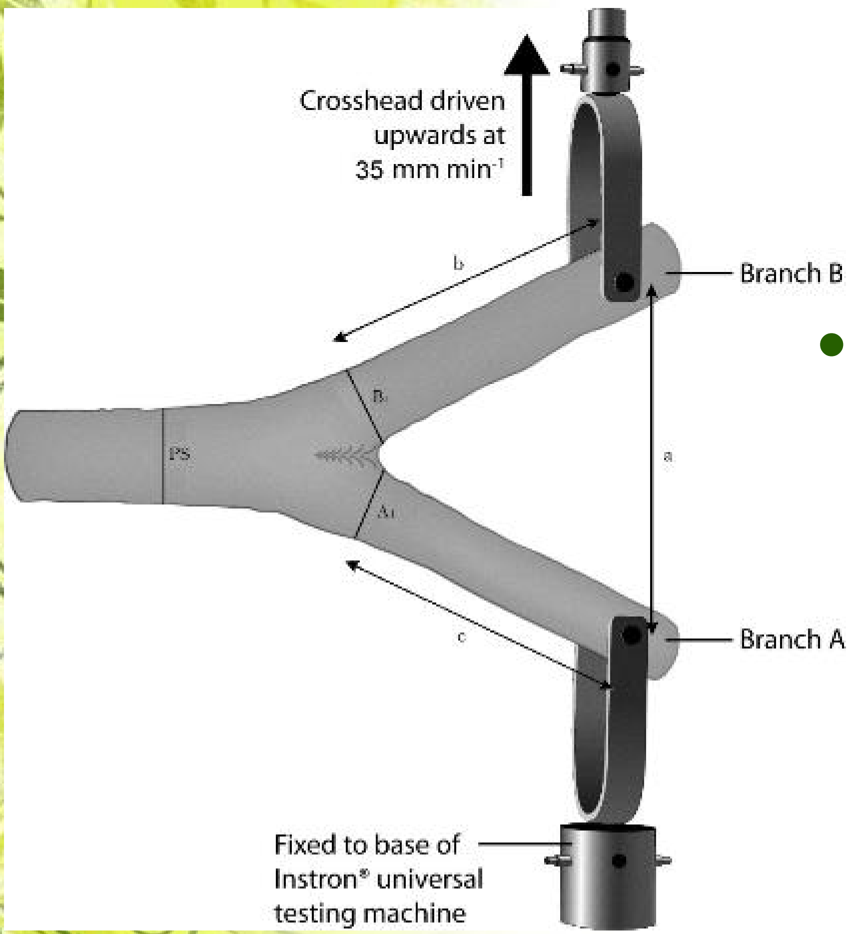
- Super Typhoon 'Mangkhut hit Hong Kong 16th September 2018 – causing a lot of tree damage!
- Our storm survey identified this distribution of failures (*n* = 1,014 damaged trees):
  - 66% branch failures
  - 13% root plate failures
  - 11% stem failures
  - 10% branch junction failures
    - 4.7% BI junctions
    - 4.9% Epicormic branches
    - 0.5% Normal branch junctions

To Make Trees Safe: Remove All Their Branches! ;-)

Topped birch tree on recently-built housing estate

Three growing seasons later...

Challenging old theories



- Static testing often done with c. 50 mm of branch lengths
- We are testing at:
  - 100 mm,
  - 200 mm,
  - 400 mm
  - 800 mm
- The failure mode changes

SUMMARY – Part One

- The primary cause of BI junctions is via natural bracing
- We can formatively prune trees to prevent the creation of BI junctions
- BI junctions should be assessed by taking into account any natural bracing – they do not inevitably fail
- Tree pruning guidelines and standards need to be updated

SUMMARY – Part Two

- Big bulges at a bark inclusion indicate there is definitely a defect inside
- Big bulges at a bark inclusion do not mean it is more likely to fail
- If you consider forks as defects in trees – YOU WILL CONDEMN MOST TREES! Fortunately, data doesn't support this theory.

Thank You For Listening...

And thank you for inviting me ☺

謝謝！

Duncan Slater BSc BA MSc MEd PhD MArborA MICFor